



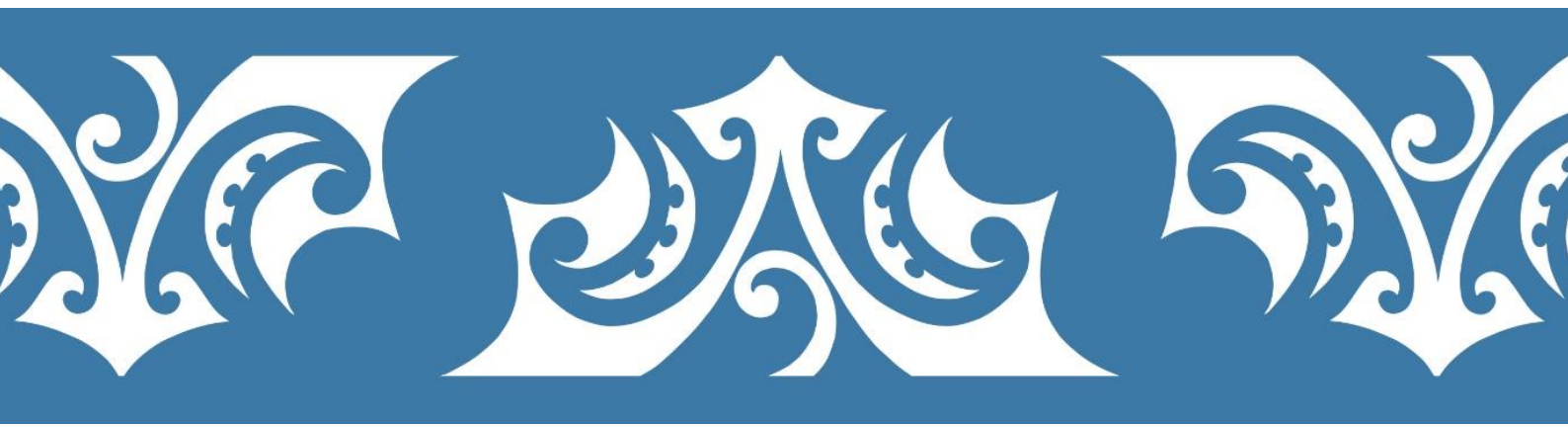
Transport Accident
Investigation
Commission

Final report

Tuhinga whakamutunga

Aviation inquiry AO-2023-003
Runway excursion (veer-off)
Boeing 777-319ER, ZK-OKN
Auckland International Airport
27 January 2023

May 2025



The Transport Accident Investigation Commission

Te Kōmihana Tirotiro Aituā Waka

No repeat accidents – ever!

“The principal purpose of the Commission shall be to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future, rather than to ascribe blame to any person.”

Transport Accident Investigation Commission Act 1990, s4 Purpose

The Transport Accident Investigation Commission is an independent Crown entity and standing commission of inquiry. We investigate selected maritime, aviation and rail accidents and incidents that occur in New Zealand or involve New Zealand-registered aircraft or vessels.

Our investigations are for the purpose of avoiding similar accidents and incidents in the future. We determine and analyse contributing factors, explain circumstances and causes, identify safety issues, and make recommendations to improve safety. Our findings cannot be used to pursue criminal, civil, or regulatory action.

At the end of every inquiry, we share all relevant knowledge in a final report. We use our information and insight to influence others in the transport sector to improve safety, nationally and internationally.

Commissioners

Chief Commissioner	Jane Meares (until 30 September 2024)
Chief Commissioner	David Clarke (from 1 October 2024)
Deputy Chief Commissioner	Stephen Davies Howard
Commissioner	Paula Rose, QSO
Commissioner	Bernadette Roka Arapere
Commissioner	David Clarke (until 30 September 2024)

Key Commission personnel

Chief Executive	Martin Sawyers
Chief Investigator of Accidents	Naveen Kozhuppakalam
Investigator-in-Charge for this inquiry	Ian M ^c Clelland
Acting Commission General Counsel	Polly Leeming

Notes about Commission reports

Kōrero tāpiri ki ngā pūrongo o te Kōmihana

Citations and referencing

The citations section of this report lists public documents. Documents unavailable to the public (that is, not discoverable under the Official Information Act 1982) are referenced in footnotes. Information derived from interviews during the Commission's inquiry into the occurrence is used without attribution.

Photographs, diagrams, pictures

The Commission owns the photographs, diagrams and pictures in this report unless otherwise specified.

Verbal probability expressions

For clarity, the Commission uses standardised terminology where possible.

One example of this standardisation is the terminology used to describe the degree of probability (or likelihood) that an event happened, or a condition existed in support of a hypothesis. The Commission has adopted this terminology from the Intergovernmental Panel on Climate Change and Australian Transport Safety Bureau models. The Commission chose these models because of their simplicity, usability, and international use. The Commission considers these models reflect its functions. These functions include making findings and issuing recommendations based on a wide range of evidence, whether or not that evidence would be admissible in a court of law.

Terminology	Likelihood	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	



Figure 1: Boeing 777-319ER, ZK-OKN
(Credit: Eddie Heisterkamp)



Figure 2: Location of accident
(Credit: Land Information New Zealand Toitū te Whenua)

Contents

Rārangi take

1	Executive summary.....	1
	What happened.....	1
	Why it happened	1
	What we can learn.....	1
	Who may benefit	2
2	Factual information	3
	Narrative.....	3
	Post-occurrence events	6
	Personnel information	6
	Aircraft information	7
	Autopilot	7
	Flight recorders.....	8
	Aeroplane damage.....	9
	Meteorological information.....	10
	Communications and aids to navigation.....	11
	Aerodrome information	11
	Organisational information.....	12
	Flare and touchdown.....	13
3	Analysis.....	14
	Introduction	14
	Background	14
	The flight	15
	Weather considerations	15
	Aeroplane landing performance	16
	Visibility.....	16
	Runway closure.....	17
	Autopilot disengagement.....	18
	Flight data recordings	18
	Pilot guidance.....	21
	Data review.....	22
	Approach and landing briefing	23
4	Findings	25

5	Safety issues and remedial action	26
	General.....	26
	Safety issue	26
	Autopilot disengagement.....	26
	Other action taken	27
6	Recommendations.....	28
	General.....	28
7	Key lesson.....	29
8	Data summary.....	30
9	Conduct of the inquiry	31
	Abbreviations.....	32
	Glossary	33
	Citations	34
Appendix 1	Air New Zealand: Standard Operating Procedures	35
Appendix 2	Boeing Flight Crew Training Manual	36

Figures

Figure 1: Boeing 777-319ER, ZK-OKN	iii
Figure 2: Location of accident	iv
Figure 3: Auckland Aerodrome (Credit: Land Information New Zealand)	5
Figure 4: Right main land gear shortly after shutdown (Credit: Air New Zealand).....	6
Figure 5: Tyre damage	9
Figure 6: Runway edge lights	10
Figure 7: Boeing 777 ZK-OKN nearing the runway (Credit: Auckland International Airport Limited)	12
Figure 8: DFDR data	20
Figure 9: Tyre marks (Credit: Auckland International Airport Limited).....	21

1 Executive summary

Tuhinga whakarāpopoto

What happened

- 1.1. On the evening of Friday 27 January 2023, Boeing 777-319ER ZK-OKN was returning to land at Auckland, having flown from Auckland to Melbourne earlier that day. As the aeroplane approached Auckland, heavy rain was encountered and the wind changed in direction and strength.
- 1.2. As the aeroplane neared the runway it began to drift right of the runway centreline. Soon after touchdown it veered off the runway onto a sealed shoulder. The aeroplane struck six runway edge lights before returning to the centre of the runway.
- 1.3. The aeroplane was taxied to the gate and passengers off loaded. An inspection of the aeroplane revealed that five of the six right landing-gear tyres were damaged and one of these had deflated. There was also damage to the right brake assembly and wiring harness. There were no injuries.

Why it happened

- 1.4. The Transport Accident Investigation Commission (the Commission) found that the heavy rain **likely** contributed to the decision to disengage the autopilot low in the approach. The timing of the autopilot disengagement combined with the technique used by the pilot flying, **very likely** resulted in there being insufficient time to correct the flightpath of the aeroplane before landing. The pilot flying was therefore unable to prevent the aeroplane drifting away from the centreline before landing and stop it veering off the runway after landing. The weather, while inclement, was above the minimum weather requirements throughout the approach and landing.
- 1.5. The Commission found it **exceptionally unlikely** that the heavy rain contaminated the runway to the extent that it caused the runway excursion.
- 1.6. While it was **exceptionally unlikely** that poor briefings contributed to the runway excursion, the Commission found that the approach and landing briefing did not meet the operator's guidelines. For example, the briefing did not make any reference to how the final approach and landing were to be conducted.

What we can learn

- 1.7. Operator and aircraft manuals and procedures are designed to help ensure an aircraft is flown as safely as possible in both normal and adverse circumstances. Knowledge and understanding of these documents, complemented by an appropriate recurrent training programme, helps mitigate the risk of an adverse outcome.
- 1.8. It is important that crews act in a cohesive manner and are as prepared as possible for any unforeseen eventualities. A good briefing, which is a core element of crew resource management, helps ensure a crew has a shared mental model, that critical factors are identified and any risks reduced to acceptable levels.

Who may benefit

- 1.9. All pilots and operators may benefit from the findings and lessons in this report.

2 Factual information

Pārongo pono

Narrative

- 2.1. The following section draws on information obtained through cockpit voice recorder (CVR), quick access recorder (QAR) and digital flight data recorder (DFDR) recordings, air traffic control (ATC) recordings and interviews of key personnel.
- 2.2. On Friday 27 January 2023, a Boeing 777-319ER ZK-OKN (the aeroplane), operated by Air New Zealand (the operator), was scheduled for an Auckland-to-Melbourne and return flight. The flight crew reported for duty by 0750.¹ The flight crew was an augmented crew², consisting of a captain, a first officer and a second officer. The flight departed Auckland on schedule at 0905, with the first officer as the pilot flying (PF) and the captain as the pilot monitoring (PM).³ The flight to Melbourne was uneventful.
- 2.3. The aeroplane departed Melbourne as flight NZ124 on schedule at 1410, with 287 persons on board, comprising 16 crew and 271 passengers. The captain was now the PF and the first officer was the PM. The second officer rotated seats with the pilots to allow them to take short breaks during the cruise phase of the flight.
- 2.4. At 1700, about 15 minutes (min) before starting the descent into Auckland, the PF obtained the current aerodrome weather information for Auckland through the automatic terminal information service (ATIS)⁴. The runway was reported as wet with visibility of 5 kilometres (km) reducing to 3000 metres (m) in rain, and cloud as low as 800 feet (ft) (245 m). The surface wind was 030 degrees magnetic at 23 knots (kt) (43 km/h), minimum 12 kt (22 km/h). The PF and PM discussed that both the temperature and dew point⁵ were the same at 19°C, indicating there was significant moisture and cloud present. Comment was also made that there would probably be storms passing through that might affect the approach. (See paragraph 2.39 for the full ATIS report.)
- 2.5. At 1702, the PF advised the service director⁶ to prepare for landing early as it 'could be a bit bumpy'. The second officer returned to the flight deck from the crew rest area at about this time.
- 2.6. At 1706 the PM changed the radio frequency to Auckland approach control, advising the controller that they were in receipt of the current ATIS information, information TANGO⁷. The approach controller cleared the aeroplane for a standard arrival route

¹ Times in this report are in New Zealand Daylight Time (Coordinated Universal Time + 13 hours) and are expressed in the 24-hour format.

² The Boeing 777 is approved for two-pilot operations. These may be augmented with additional pilots for longer flights or training.

³ The PF is the person operating the flight controls, while the PM is the person responsible for monitoring the course of the flight and radio communications with ATC, flight attendants and passengers.

⁴ A continuous broadcast of aerodrome information, including such items as expected type of approach, runway in use, runway condition (dry, wet or contaminated), surface wind, visibility, cloud, temperature, dew point, local pressure and the reported or forecast wind at 2000 ft

⁵ The temperature at which air becomes saturated and can hold no more moisture

⁶ The senior cabin crew person

⁷ To aid in identifying the most current ATIS report, each new report is allocated the next letter in the phonetic alphabet, starting the day with Alpha.

(STAR) procedure for runway 05R⁸ and confirmed the current weather information for the aerodrome. The PM acknowledged the clearance.

- 2.7. At 1708 the PF advised the crew "Okay, so ARADI SEVEN BRAVO (the STAR) is in there. ILS 05 right" (instrument landing system approach for runway 05R). This meant that the arrival and instrument approach procedures were loaded into the flight management computer (FMC). This was acknowledged by the PM. The crew then discussed the weather conditions for the approach, including flying at a slower speed to reduce the effects of possible turbulence during the descent.
- 2.8. At 1709 the approach controller cleared the aeroplane to descend when ready. Descent was started at 1716. Speed restrictions, tracking instructions and radio frequency changes were passed by the approach controller as the aeroplane descended.⁹
- 2.9. At 1719 the PF called for the approach checklist. The PM confirmed the altimeter pressure setting and advised "approach checklist complete". At 1733 the air traffic controller cleared the flight to descend to "3000 ft [914 m], ILS/DME [instrument landing system/distance measuring equipment] approach 05R". Soon after, the PF reported that they were able to "see the coast down there", referring to the coastline west of Auckland. The PF then commenting that the "wind must swing around shortly". At 1734, the controller advised that the ATIS information had been updated and that the only change was a 1 hectopascal (hPa) increase in the surface pressure.
- 2.10. At 1735 the PM reported that the aeroplane was established on the localiser (the inbound track for the ILS) and was advised to change to the tower frequency. The tower controller confirmed the aeroplane was following another aeroplane, a Metroliner¹⁰, on the instrument approach and that the visibility was "quite nasty final approach, only around a couple of thousand metres". The PF and PM agreed they had plenty of fuel on board should a diversion to Christchurch be required.
- 2.11. At 1736:51, when approaching 2500 ft [662 m], the crew observed that the wind direction was changing and starting to come around. At 1737:35 the PF commented, "There's going to be a bit of crosswind, I think". The PM responded that the wind was "backing"¹¹ and was expected to back to "030° at 18 kt (33 km/h), so a little bit".
- 2.12. At 1737:52 the preceding Metroliner landed. About this time the landing checklist for the flight was completed and the PM commented that they would "get some fluctuations [in the wind] for sure". The PF replied that the wind was "coming around onto the nose". The PM in turn responded, "That's probably what's causing these bumps."
- 2.13. At 1738:21 the tower controller advised that the Metroliner had landed and visibility was very poor on final approach, "perhaps 1500 metres". The tower controller then cleared the aeroplane to land and reported the surface wind as 020° at 14 knots (26 km/h). The PM read back the landing clearance followed by the PF asking "You happy?". The PM responds with "Yep". The aeroplane was at about 1200 ft (365 m) at

⁸ Runways are referenced to the nearest 10 degrees magnetic bearing. Runway 05R is therefore aligned on 050°. The 'R' signifies that it is the 'right' runway on 050°. The '05L' or '05 left' runway was the main taxiway, occasionally used as a backup runway.

⁹ To provide separation and sequencing with other aircraft.

¹⁰ A 19-seat twin-turboprop(ellor) aeroplane.

¹¹ Moving in an anti-clockwise direction.

this time. The window-wiper speed was increased in response to the rain being encountered.

- 2.14. At 1739.45 the PM reported seeing the runway approach lights. At 1739.55 the tower controller advised that the “vis [visibility] is around 1200 m at the moment”. At 1740.03 the PF called ‘visual’, with the runway in sight. The aeroplane was at about 320 ft (97 m) above the runway at this time. At 1740:17 the PF reported losing sight of the runway between a pass of the wiper blades. The PM immediately responded saying that they continued to be visual with the runway. The PF then confirmed that they were visual with the runway again.
- 2.15. At 1740:25 the PF advised disengaging the autopilot. The aeroplane was at 90 ft (27 m) above mean sea level (AMSL) (67 ft [20 m] above ground level [AGL]) when the autopilot was disengaged. The PF started flaring the aeroplane¹² for landing 3 seconds later. At 1740:32 the PM called “you’re left of centreline”.¹³ The DFDR recorded touchdown (a weight on both main landing-gear wheels) at 1740.34. This was immediately followed by the PF selecting reverse thrust and the PM advising, “Centreline’s just to the left, come to the left”. The nose wheel touched down at 1740:40.
- 2.16. About 20 s after landing, the PM observed a tyre-low-pressure indication on the right main landing gear. The PM informed the tower controller and advised them of potential debris on the runway. The aeroplane exited the runway at taxiway A3 as usual and taxied to its allocated gate at the International Terminal (see Figure 3). After shutdown, the right main landing gear was inspected and the rear inboard tyre was confirmed to have deflated (see Figure 4).

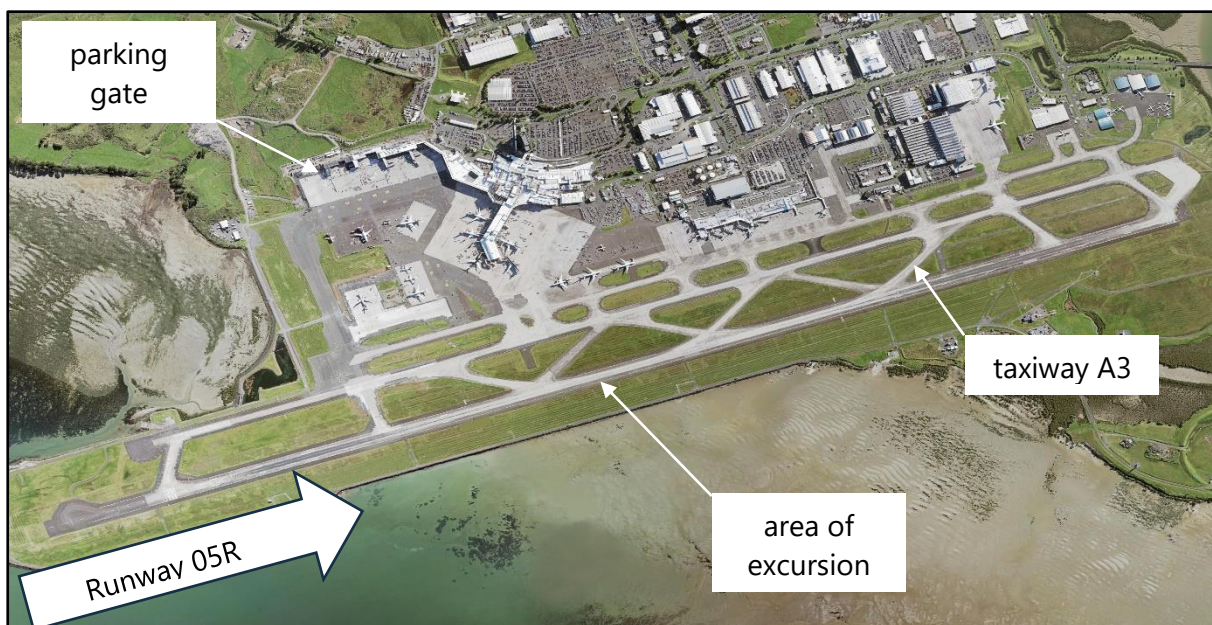


Figure 3: Auckland Aerodrome

(Credit: Land Information New Zealand Toitū te Whenua)

¹² Raising the nose of the aeroplane to the landing attitude.

¹³ Flight data evidence confirmed the aeroplane was right of the centreline at this time and the PM simply misspoke. None of the crew expressed any confusion at the time or later at interview.



Figure 4: Right main landing gear shortly after shutdown
(Credit: Air New Zealand)

Post-occurrence events

- 2.17. The tower controller, after receiving the report of possible damage to the runway edge lights, immediately advised a second Air New Zealand flight on final approach of the situation. The captain of that aircraft elected to go around and diverted to Christchurch. The tower controller then requested a runway inspection by Auckland International Airport Limited (AIAL) staff.
- 2.18. At 1752, 10 min after the occurrence, information from the aerodrome's ATIS was updated to advise traffic that the runway was closed because of foreign-object debris or damage (FOD). At 1759, the Airways New Zealand National Briefing Office issued a Notice to Air Mission (NOTAM)¹⁴ advising that runway 05R/23L was closed. The NOTAM was updated at 1818 to state that the runway was closed for arriving aircraft only. At 1849 a scheduled flight took off from Auckland for Melbourne.
- 2.19. At 2029 a NOTAM was issued advising that runway 05R/23L was open and previous NOTAMs were cancelled. At 2108 a NOTAM was issued advising that runway 05R/23L was closed to all scheduled passenger arriving flights. This was because of flooding at the passenger terminals and the inability to process passengers, not because of the runway excursion¹⁵. The closure remained valid until 1021 the following day.

Personnel information

- 2.20. The captain held an Airline Transport Pilot Licence (Aeroplane) and a current Class 1 medical certificate. They had joined the operator in 1985, progressed through various aeroplane types and become a captain on the Boeing 777 in August 2014. In 2020 the operator's Boeing 777 fleet had been removed from service because of COVID-19, and the captain had flown the Boeing 787. They had returned to the Boeing 777 in

¹⁴ A notice filed by an aviation authority to alert pilots to a potential hazard

¹⁵ When an aircraft departs a runway in use when landing or taking off, as either a veer-off or an overrun.

February 2022. At the time of the occurrence they had accrued some 24,000 flying hours, including 5183 hours on the Boeing 777.

- 2.21. The captain's most recent duty had been five days before the occurrence and involved a flight from Auckland to Sydney and return. The captain reported that they had been well rested and in good health on the day of the occurrence. They had no medical certificate endorsements or restrictions, or other medical issues considered relevant to the occurrence.
- 2.22. The first officer held an Airline Transport Pilot Licence (Aeroplane) and a current Class 1 medical certificate. They had joined the operator in 1998, progressing through various aeroplane types before flying the Boeing 777 in May 2014. The first officer, like the captain, had flown the Boeing 787 for approximately 16 months before returning to the Boeing 777 in January 2022. At the time of the occurrence they had accrued some 19,400 flying hours, including 5248 hours on the Boeing 777.
- 2.23. The first officer's most recent duty had been a flight from Auckland to Sydney and return the day before the occurrence. This had been preceded by a rostered day off. The first officer reported that they had been well rested and in good health on the day of the occurrence. They had no medical certificate endorsements or restrictions, or other medical issues considered relevant to the occurrence.
- 2.24. The second officer held an Airline Transport Pilot Licence (Aeroplane) and a current Class 1 medical certificate. They had joined one of the operator's subsidiaries in February 2010, initially flying the Beechcraft 1900D. They had then flown the ATR-72 before starting training on the Boeing 777 in October 2022. At the time of the occurrence they had accrued a total of some 7650 flying hours, including 125 hours on the Boeing 777.
- 2.25. The second officer's most recent duty had been a flight from Auckland to Los Angeles and return five days before the occurrence. They reported that they had been well rested and in good health on the day of the occurrence. They had no medical certificate endorsements or restrictions, or other medical issues considered relevant to the occurrence.

Aircraft information

- 2.26. The aeroplane was a Boeing 777-319ER, registration ZK-OKN, serial number 38406. It had first been flown in February 2011 and had been delivered to the operator later in the same month. The aeroplane was powered by two General Electric GE90-115B turbofan engines.
- 2.27. The aeroplane was configured to carry 332 passengers in three classes. The minimum flight crew was two pilots, which could be supplemented depending on the length of flight. No technical issues were identified that were relevant to the occurrence.

Autopilot

- 2.28. The Boeing 777 was equipped with an autopilot that supported fully automated flight. The autopilot used a back-driven system, whereby inputs to the flight controls¹⁶ would be fed back, resulting in a corresponding movement of the pilots' controls.¹⁷

¹⁶ The flight controls or control surfaces include the elevator, rudder and ailerons.

¹⁷ Control column and rudder pedals

For example, if the autopilot commanded left rudder input, the rudder would move causing the pilot's left rudder pedal to move forward and the right pedal to move aft. When the autopilot was disengaged the flight controls would return to the neutral position and the aeroplane would manoeuvre as a consequence, potentially away from the previously intended flightpath. To prevent this and maintain the same desired flightpath, the pilot must maintain the same control inputs when disengaging and not let them move to neutral.

- 2.29. The aeroplane was capable of performing an 'autoland'¹⁸ on approved runways. The operator's Boeing 777 Route Guide listed runway 23L at Auckland as approved for autolands, but the reciprocal runway 05R was approved for practice autolands only.
- 2.30. The Boeing 777 autopilot also had a runway-alignment capability, which was a sub-mode of the approach mode. When a crosswind was present during an approach, the aeroplane needed to be pointed partially into the crosswind to ensure the flightpath remained aligned with the runway. This offset was termed the 'crab angle'. The stronger the crosswind, the greater the crab angle required. The runway-alignment mode was also designed to handle single-engine approaches, compensating for the asymmetric thrust from only one engine.
- 2.31. During the final stages of an approach with the autopilot engaged, the runway-alignment mode would reduce the crab angle at touchdown. When, how and how much the crab angle was reduced depended on the strength of the crosswind. The Flight Crew Operations Manual (FCOM) provided pilots with guidance on the subject and stated the following:

For crosswinds requiring more than 10° of crab angle, runway alignment occurs at 500 ft [feet] AGL. A sideslip of 5° is established to reduce the crab angle. This configuration is maintained until touchdown. The airplane lands with the upwind wing low.

For crosswinds requiring a crab angle of between 5° and 10°, an initial alignment occurs at 500 ft AGL, followed by a second alignment at 200 ft AGL. The initial alignment initiates a sideslip to reduce the crab angle to 5°. This configuration is maintained to 200 ft AGL, where a second sideslip alignment increases the sideslip to further reduce the touchdown crab angle.

For crosswinds requiring a crab angle of less than 5°, no runway alignment occurs until 200 ft AGL, where a sideslip is introduced to align the airplane with the runway. (FCOM 4.20.14)

Flight recorders

- 2.32. The aeroplane was fitted with a quick-access recorder (QAR), a cockpit voice recorder (CVR) and a digital flight data recorder (DFDR). The QAR was a non-crashworthy recording system, primarily used by an operator for quality-assurance purposes. The QAR data was downloaded for the Commission with the assistance of the operator.
- 2.33. The CVR and DFDR were both L3 Communication recorders, model FA2100. The CVR was capable of recording 2 hours of flightdeck voice communication over four channels in a continuous loop. The channels included one for each seat position and a flightdeck area microphone.

¹⁸ A landing using the autopilot, with the pilot in the left seat taking over directional control during the landing roll (when the aircraft touches down, is brought down to taxi speed and eventually comes to a complete stop).

- 2.34. The DFDR was capable of recording some 1645 parameters over 25 hours. The parameters included control positions, engine performance and flight conditions such as altitude, height, heading and speed.
- 2.35. The CVR and DFDR were removed from the aeroplane under Commission supervision and taken to the Australian Transport Safety Bureau's (ATSB's) recorder facility in Canberra for downloading and verification. Commission investigators were present for the downloads. The downloaded data was confirmed as being of good quality. The CVR recorded the final 2 hours of the flight through to when it was powered off after the aeroplane arrived at the gate. The voices of the three pilots were clearly identifiable. The DFDR recorded the occurrence flight and the preceding eight flights.

Aeroplane damage

- 2.36. The right main landing gear was examined soon after the aeroplane arrived at the gate. The aeroplane was then towed to a hangar and quarantined.
- 2.37. A more detailed examination of the right main landing gear found five of the six tyres displayed cut, puncture or imprint damage. Many of the imprints matched the shape of the broken bases of the runway edge lights (see Figure 5 and Figure 6). There was also damage to the landing-gear brake assembly, wiring harness and brackets. All six tyres were replaced, either because of damage or because they had exceeded the overstress weight limit. The aeroplane was returned to service within a week of the occurrence. (See paragraph 2.46 regarding runway damage.)

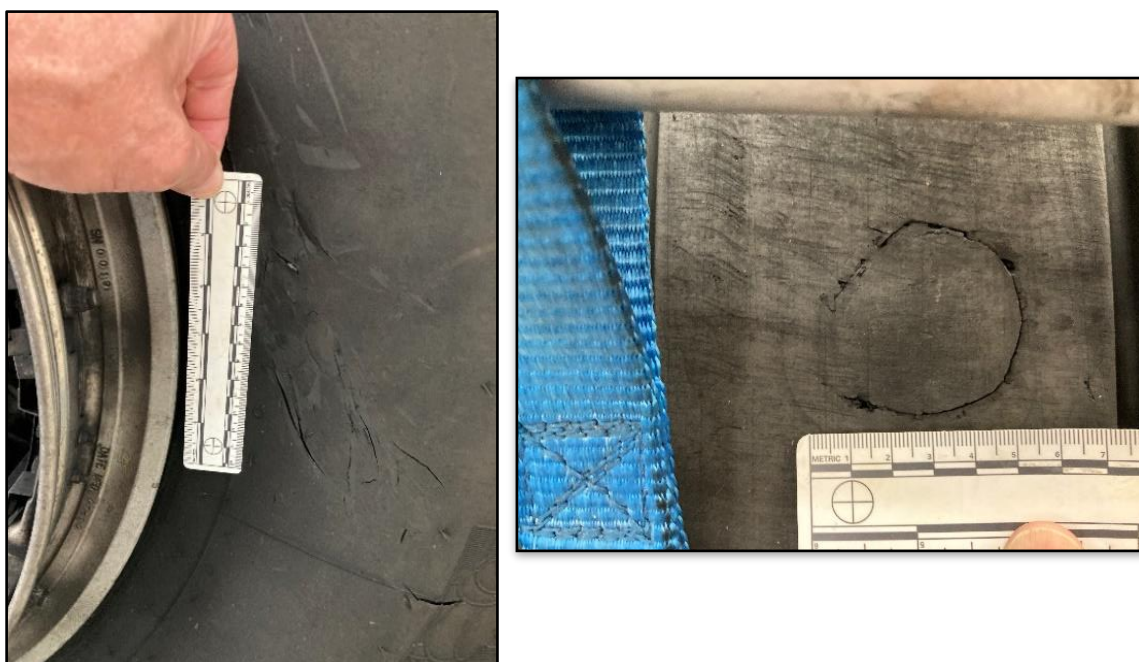


Figure 5: Tyre damage



Figure 6: Runway edge lights

Meteorological information

- 2.38. Commission investigators obtained weather information from a variety of sources. These included ATIS reports and MetService¹⁹ forecasts, actual weather reports, and radar images for Auckland covering the duration of the flight. A weather station on the aerodrome located near the far end of runway 05R, about 3 km from the touchdown zone, provided minute-by-minute recordings of local conditions. These included recordings of surface wind and rainfall rates.
- 2.39. The ATIS ‘information Tango’ that was current and reviewed by the crew when the flight initially approached Auckland provided the following information:
- ILS/DME instrument approach for runway 05R
 - runway wet
 - vacate taxiway Alpha 3
 - surface wind 030° magnetic at 23 kt [43 km/h], minimum 12 kts[22 km/h]
 - visibility 5 km, reducing to 3000 m in rain
 - cloud scattered at 800 ft [245 m], broken at 1000 ft [305 m] and broken at 1800 ft [548 m]²⁰
 - temperature 19°C
 - dew point 19°C
 - QNH (pressure) 1008 hPa
 - reported 2000-foot wind 040°magnetic at 31 kt [57 km/h].

This ATIS was updated with ‘information Uniform’ at 1734, as the flight became established on the ILS/DME approach. The changes included the surface wind

¹⁹ Meteorological Service of New Zealand.

²⁰ Cloud cover is measured in okta, a unit representing 1/8 of the sky. Cloud cover is estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 to 8 oktas. Scattered is 3–4 okta, broken 5–7 okta.

reducing to 030° magnetic at 18 kt [43 km/h] and the QNH²¹ pressure increasing to 1009 hPa. All other information remained the same.

2.40. Auckland routine meteorological reports or METARs, were issued every 30 min on the half hour. The METAR issued at 1730 and current when the flight landed provided the following information:

- surface wind 050° true at 16 kt [30 km/h], varying between 010° and 070° true
- visibility 5000 m
- rain and mist present
- cloud scattered at 900 feet [274 m], broken at 4800 feet [1465 m] and overcast at 10000 feet [3050 m]
- temperature 19°Celsius (°C), dew point 19°C
- QNH (pressure) 1008 hPa.

2.41. The weather station on the aerodrome recorded the rainfall rates for the 5 min either side of the landing (see Table 1).

Table 1: Recorded rainfall at the aerodrome

Time	Rate mm/minute
1735	0.2
1736	0.4
1737	0.4
1738	1.0
1739	1.0
1740*	1.0
1741	0.8
1742	1.0
1743	0.6
1744	0.8
1745	1.2

*Time of landing, 1740:34

2.42. The rainfall rate started to increase significantly from about 1900, peaking around 2.2 mm/min at about 1945.

Communications and aids to navigation

2.43. Commission investigators obtained from Airways New Zealand ATC radio communications for the Auckland approach, tower and ground radio frequencies. They also obtained aircraft tracking data, starting from the time the aeroplane was about 200 NM from Auckland until it was on the gate.

Aerodrome information

2.44. The total length of runway 05R was 3655 m, with an available landing distance of 3230 m. The runway was 45 m wide, with a sealed shoulder of 15 m either side of the

²¹ Pressure referenced to mean sea level.

runway. The first 7.5 m out from the runway had full load-bearing capabilities. The outside 7.5 m had partial load-bearing capabilities and was susceptible to damage after repeated heavy aircraft operations.

- 2.45. The runway was not grooved²² like many of the shorter runways around New Zealand. However, the aerodrome operator advised that the cross-runway camber or curvature was slightly greater than the norm.
- 2.46. Runway lighting included runway centreline and edge lights. The centreline lights were flush mounted, while the edge lights were positioned every 60 m on the outside of the painted runway edge. The edge lights were mounted on 20-cm high pedestals and designed to be frangible – to break-off at their bases in the event of being struck. A total of six runway edge lights had been struck and broken off at their bases.
- 2.47. The aerodrome was equipped with a number of closed-circuit television (CCTV) cameras about the runway and terminals. The Commission obtained the footage of 18 cameras that had recorded ZK-OKN landing at the aerodrome and taxiing to the terminal. These included the two runway-end cameras (see Figure 7).



Figure 7: Boeing 777 ZK-OKN nearing the runway
(Credit: Auckland International Airport Limited)

Organisational information

- 2.48. The operator was based in Auckland and their fleet included eight Boeing 777-300ER aeroplanes. The fleet was typically used on long-haul routes, for example to Japan and the United States. The aeroplanes were also used on some shorter trans-Tasman routes.

Approach briefing

- 2.49. The operator's Boeing 777 standard operating procedures (SOPs) and flight crew training manual (FCTM) gave pilots guidance on operating the aeroplane, including conducting approach briefings. The SOPs stated that the purpose of a briefing was to:

²² Had not been cut across to assist with water runoff and aid braking.

- identify threats relevant to an approach
 - identify strategies to manage those threats
 - confirm the planned operation of the aircraft.
- 2.50. The briefing was to follow the mnemonic of T-CTWO: Threats - Chart, Terrain, Weather and Operations.
- 2.51. The FCTM provided further guidance on the information that should be included in an approach and landing briefing. This included specific reference to the Autopilot and Flight Management System. See Appendices 1 and 2 for the briefing content.

Flare and touchdown

- 2.52. The FCTM for the Boeing 777 described the landing techniques applicable to all situations, including crosswind landings and landings on slippery runways. It stated the need to 'begin with a stabilised approach on speed, in trim and on glidepath'. This was immediately followed by a note that stated:

When a manual landing is planned from an approach with the autopilot connected, the transition to manual flight should be planned early enough to allow the pilot time to establish airplane control before beginning the flare²³. The PF should consider disengaging the autopilot and disconnecting (if desired) 1–2 nm [nautical miles] before the threshold, or approximately 300–600 feet [90–180 m] above field elevation.²⁴

²³ Raising the nose of the aeroplane to the landing attitude.

²⁴ Chapter 6 Landing, page 6.8

3 Analysis Tātaritanga

Introduction

Background

- 3.1. A 2009 safety report by the ATSB found that, worldwide, commercial aircraft hull loss rates had steadily decreased since 1996²⁵. This was especially so for controlled flight into terrain (CFIT)²⁶ accidents, which accounted for most fatalities. The use of technology, such as enhanced ground-proximity warning, played a major role in reducing this type of accident. Despite this, approach and landing accidents continue to 'dominate as the primary cause of commercial hull losses' (Australian Transport Safety Bureau, 2009, April).
- 3.2. The report found that 'a range of flight crew techniques and decisions, weather, flight crew performance, and systems-related factors were identified as contributing to runway excursion accidents [as an overrun²⁷ or veer-off²⁸] during the landing phase of flight'²⁹. It went on to list a range of factors that, if not identified and managed effectively by flight crew, could increase the risks of an accident occurring. These included flying an unstabilised approach, 'press-on-itis' and 'less than adequate flight crew awareness of procedures or systems'.
- 3.3. A 2015 study by Future Sky Safety, a consortium of European regulators, operators, aircraft manufacturers and universities, found that runway excursions remained the most common type of reported accidents. While the number of CFIT accidents had decreased in the preceding 20 years, the number of runway excursion accidents had remained consistent (Future Sky Safety, 2015, December 14).
- 3.4. The study used a taxonomy of 31 standard descriptions to describe the causal factors contributing to veer-off occurrences. The leading 16 factors by frequency were listed as:

1. Crew performance inaccurate	56%
2. Wet/contaminated runway	25%
3. Crosswind	24%
4. Inaccurate information to crew	23%
5. Technical issue: landing gear	16%
6. Gust	12%
7. Technical issue: steering system	11%
8. Asymmetric thrust	11%
9. Unstable approach	8%
10. Hard landing	7%
11. Deteriorating/poor visibility	7%
12. Heavy precipitation	6%

²⁵ The destruction or write-off an aircraft

²⁶ An airworthy aircraft under the complete control of a pilot is inadvertently flown into terrain, water or an obstacle

²⁷ An aircraft departs the end of a runway

²⁸ An aircraft departs the side of a runway

²⁹ A lateral runway excursion off the side of a runway.

13. Aquaplaning	5%
14. Technical issue: hydraulics	5%
15. Maintenance issue	4%
16. Technical issue: Braking system	4% ³⁰

3.5. The study made the following comments regarding crew performance inaccurate:

This causal factor is observed in more than 50% of the occurrences for both landing and take-off. This factor was allocated to all occurrences where it was observed that action(s) or lack of action of the crew contributed to the occurrence of the veer-off. This causal factor comprises a wide range of crew handling from (in rare events) crew errors to (in most cases) non-optimal response for the situation...

The frequency of the causal factor "Inaccurate crew performance" could be lowered by crew performance training and crew awareness training. In the case of crew errors or even lack of crew discipline in following operating procedures this will be clear. In the case of crew non-optimal response when applying several on board control systems (auto braking, differential braking, nose wheel steering, rudder control) in a complex weather situation this will be more difficult.

3.6. In 2023 the International Air Transport Association completed a review of airline accidents in 2022 and 2023. The review identified runway excursion themes consistent with the above two reports. They included unstable approaches, the use of flight-management systems and communication phraseology (International Air Transport Association, 2023). In summary, CFIT accidents resulted in more fatalities when compared to runway excursions, but the rate of this type of accident was reducing. While runway excursion accidents resulted in more hull losses but fewer fatalities, the rate for this type of accident is not reducing.

The flight

- 3.7. The flight was part of a routine scheduled service from Auckland to Melbourne and return. The flight was uneventful until the aeroplane's landing back at Auckland, when it veered off the right side of the runway and struck six runway lights. The aeroplane returned to the centre of the runway before exiting it at the usual taxiway and continuing on to the terminal. As the aeroplane remained on the sealed edge of the runway the damage was limited to six lights, the main landing gear tyres on the right side and some associated aircraft wiring. The aeroplane returned to service about one week later.
- 3.8. The following sections analyse the circumstances surrounding the event to identify those factors that increased the likelihood of the event occurring or increased the severity of its outcome. They also examine any safety issues that have the potential to adversely affect future operations.

Weather considerations

- 3.9. On the day of the occurrence, Auckland was subject to a significant rain event. For the six-hour period from 1500 until 2100, some 175 mm of rain fell. The rainfall intensified

³⁰ The remaining 15 factors rated 3% or less.

during the course of the day; while the rainfall rate initially increased slowly, it accelerated after about 1845. This resulted in significant flooding, both in the city and on the aerodrome, during the evening.

- 3.10. The weather station on the aerodrome recorded that at around the time of the occurrence at 1740, the hourly rainfall rate was about 14.6 mm/h.³¹ According to the World Meteorological Organization, a rate in excess of 10 mm/h was classified as 'heavy rain' (World Meteorological Organization, n.d.). At the time the aeroplane landed the rainfall rate was 1.0 mm/min or 60 mm/h (*refer* to paragraph 2.41). The increased rainfall rate would have reduced the pilot's visibility at this time.³²
- 3.11. When the aeroplane landed, an Airbus A320 aeroplane was holding on taxiway A9, waiting to depart. The crew of the A320 reported receiving a warning on their multi-function display of windshear about 1 km to the south of the runway, not on the approach path to runway 05R. The crew also reported that the rain was intense and increasing, with momentary changes in the wind direction and/or strength. The captain of the A320 commented that the rain was 'heavy' but visibility 'was well above minimas', referring to the minimum requirements for an approach. Because of the potential for FOD on the runway ahead from the excursion, the captain of the A320 returned to the terminal.

Aeroplane landing performance

- 3.12. Pilot reports, photographs and CCTV recordings made or taken at the time of or shortly after the occurrence all showed that, while it was wet when the aeroplane landed, there was no flooding or standing water on the runway, on taxiways or around the terminal. Five minutes after the aeroplane had landed, the first of four vehicles accessed the runway to undertake damage inspections and sweep for debris. In response to a request from the tower controller, the driver of a vehicle doing a runway inspection at this time confirmed there was no flooding on the runway.
- 3.13. An examination of the aeroplane's main landing-gear tyres and the runway found no evidence of aquaplaning. Aquaplaning, also known as hydroplaning, is when water is forced under a tyre, causing the tyre to lift from the surface. This results in reduced braking performance and ability to maintain directional control. The higher speeds of aeroplanes, compounded by braking, produce superheated water. This causes damage to tyres and leaves evidence on the runway. (See paragraph 3.29 and Figure 9.)
- 3.14. Also of relevance is the fact that the aeroplane exited the runway at taxiway A3, the usual exit point in good weather conditions (*refer* Figure 3). This suggests that the rain did not reduce the aeroplane's braking ability significantly or affect the directional control of exiting the runway.

Visibility

- 3.15. The weather forecast provided to the crew at the initial briefing showed visibility at the scheduled time of landing would be 4000 m in rain with a 30% chance of visibility reducing to 2500 m with associated thunderstorms. Before top of descent, the crew received an actual weather observation (ATIS) stating visibility was 5000 m reducing

³¹ A rolling average hourly rate.

³² Heavy or very heavy rates of rainfall will clearly have a detrimental impact upon general visibility. However, in addition to any true meteorological reduction of visibility, raindrops impacting the windscreen/canopy will additionally reduce visibility. Windscreen wipers (if fitted) may not be able to fully cope with the rainfall rate. (World Meteorological Organization, n.d.)

to 3000 m in rain. During the final stages of the approach ATC advised that the visibility was 'quite nasty on approach, only a couple of thousand metres'. Then when ATC cleared the aeroplane to land they said that 'visibility is very poor on final approach, perhaps 1500 m'. Finally, when the aeroplane was at about 500 ft, ATC advised that 'vis [visibility] is around 1200 metres at the moment'. The minimum allowed visibility for runway 05R was 800 m.

- 3.16. As the aeroplane approached the runway, heavy rain did affect visibility. At 1739:45 the PM reported starting to see the runway lights and the PF concurred. At this time the aeroplane was at about 650 feet (200 m) AMSL and 3.5 km from the runway. At 1740:03 the PF reported 'visual',³³ then 14 seconds later reported momentarily losing sight of the runway. However, the PM called that they were still visual with the runway during this time and the approach was continued.
- 3.17. A loss of visual reference at this stage of an instrument approach would normally cause a pilot to initiate a go-around and missed-approach procedure. However, in this situation the crew were comfortable with continuing for three reasons. Firstly, it was a momentary loss of visual reference and the pilots knew the reason for it. The PF had glanced down at the instrument panel and looked up between sweeps of the window wipers, taking a second to focus ahead and sight the runway. Secondly, the PM confirmed they had still been able to see the runway. Finally, the aeroplane was flying on autopilot and the approach was stable.
- 3.18. The PF's momentary loss of visual reference with the runway occurred at about the position when, according to guidelines, an autopilot disengagement could have been expected. The inclement weather on the approach **likely** played a part in the PF not disengaging the autopilot until the aeroplane was crossing the threshold of the runway. This is discussed further under 'autopilot disengagement' (see paragraph 3.21 and onwards).

Runway closure

- 3.19. The runway was closed soon after the crew reported possible damage to the runway edge lights, to allow time for aerodrome staff to inspect the runway for damage and remove any debris from the broken runway lights. The need to sweep the runway rendered the first section of runway 05R unavailable for take-offs and landings. Further, the number of broken lights meant that nighttime operations in this section could not take place until most had been replaced.
- 3.20. At 1818 the runway reopened for take-offs and one aeroplane took off at 1849. By this time water had been reported on the runway but was not pooling. A short time later the aerodrome was closed to all arriving aircraft. This was in response to reports of flooding around the terminal. Flooding of the terminal meant that the aerodrome remained closed for arriving passenger flights until 1021 the following day. Other operators, for example freight operators, elected to cancel flights during this time because of the flooding, not the accident.

³³ A 'visual' call provides confirmation that: the pilot is able to maintain continuous visual reference with the terrain ahead; the visibility is equal to or greater than the minima prescribed for the approach; and the pilot is able to make a normal landing.

Autopilot disengagement

Safety issue: The procedure and techniques to be used when disengaging the autopilot in a crosswind are taught during the initial conversion course only. Without regular practice, this skill can erode with time, increasing the risk of an incorrect handling technique leading to a runway excursion.

- 3.21. The aeroplane was being flown using the autopilot system. This was coupled to the FMC, which ensured the aeroplane followed the programmed flight plan and the arrival procedure approved by ATC and loaded into the FMC. The crew, before starting the descent into Auckland, checked the current weather conditions for their arrival. The PF then loaded the anticipated instrument approach for runway 05R that the autopilot would follow.
- 3.22. The Boeing 777 was approved for autolands. The aeroplane checklist for a planned autoland and a manual landing included different pilot calls. In this occurrence, because the runway was approved for practice autolands only, an autoland had not been briefed and the relevant autoland calls were not made. At some point on the approach the PF would need to disengage the autopilot and make a manual landing.

Flight data recordings

- 3.23. As the aeroplane flew inbound on the instrument approach, the wind direction changed from having a slight right crosswind component to a left crosswind. The wind strength reduced during this time. Approaching 1000 ft (305 m) the aeroplane was appropriately configured for the landing, with the landing gear down and flaps set at 30°. ³⁴ The aeroplane was stable, with an airspeed of 146 kt (270 km/h) and a rate of descent of 650 ft (200 m) per minute. The DFDR recorded that the wind direction at this time was in a north to northeast direction, or from the left as the aeroplane flew inbound on the instrument approach.
- 3.24. Passing 500 ft (152 m), the runway alignment mode of the autopilot (as described in paragraphs 2.30 and 2.31) started applying left aileron and right rudder ³⁵ to align the aeroplane with the runway and counter the effect of the left crosswind. From 500 ft the wind conditions continued to change in both direction and strength, with the crosswind component and strength both generally reducing. The autopilot responded accordingly to hold the aeroplane on the runway centreline and maintain the target speed.
- 3.25. The PF was recorded disengaging the autopilot at 90 ft (27 m) AMSL, or 67 ft (20 m) on the radar altimeter. The aeroplane was crossing the threshold of the runway at the time, so 67 ft would have been the height above the runway. The thrust levers started to be retarded to idle 1 second after autopilot disengagement. The flare was commenced 3 seconds later. The main landing gear contacted the runway after a further 5 seconds, or about 9 seconds after the autopilot was disengaged.

³⁴ 1000 ft is the 'stable gate', when specified criteria need to be met in order to continue the approach. This includes, aircraft configuration, target airspeed and rate of descent.

³⁵ Ailerons are located on the rear of a wing and cause an aeroplane to roll about its longitudinal or fore and aft axis. The rudder is located on the vertical fin (tail) and cause an aeroplane to yaw left or right about its vertical axis.

- 3.26. As described in paragraph 2.31, in runway-alignment mode the autopilot moves the flight controls and this in turn is back-fed to the pilot's controls. If the autopilot is disengaged in this mode, the flight controls would return to the neutral position. To continue the correct flightpath established by the autopilot a pilot has to hold the flying controls in the same position that the autopilot had maintained when the pilot disengaged the autopilot.
- 3.27. The DFDR recorded that when the autopilot was disengaged the flight controls immediately returned to their neutral position (see Figure 8). This showed that the PF did not hold the control inputs that had been applied by the autopilot, namely left aileron. As a consequence, the aeroplane rolled right by 3.69°. The aeroplane then started to drift to the right and off the runway centreline.
- 3.28. Also shown in Figure 8, at the same time the wind, while not strong or gusty, was decreasing in speed and backing around more to the left. Review of the flight data information showed that in the 15 seconds before the autopilot was disengaged the left crosswind component reduced from 20 kt to 5 kt, then fluctuated by 1 or 2 kt until touchdown. The combination of the initial roll right after disengaging the autopilot and the crosswind from the left was unable to be countered by the PF before the aeroplane exited the runway and struck the six edge lights. Regardless of the runway conditions, given this combination of actions it is **virtually certain** the aeroplane would still have left the runway.

B777-319ER ZK-OKN Runway Excursion FDR

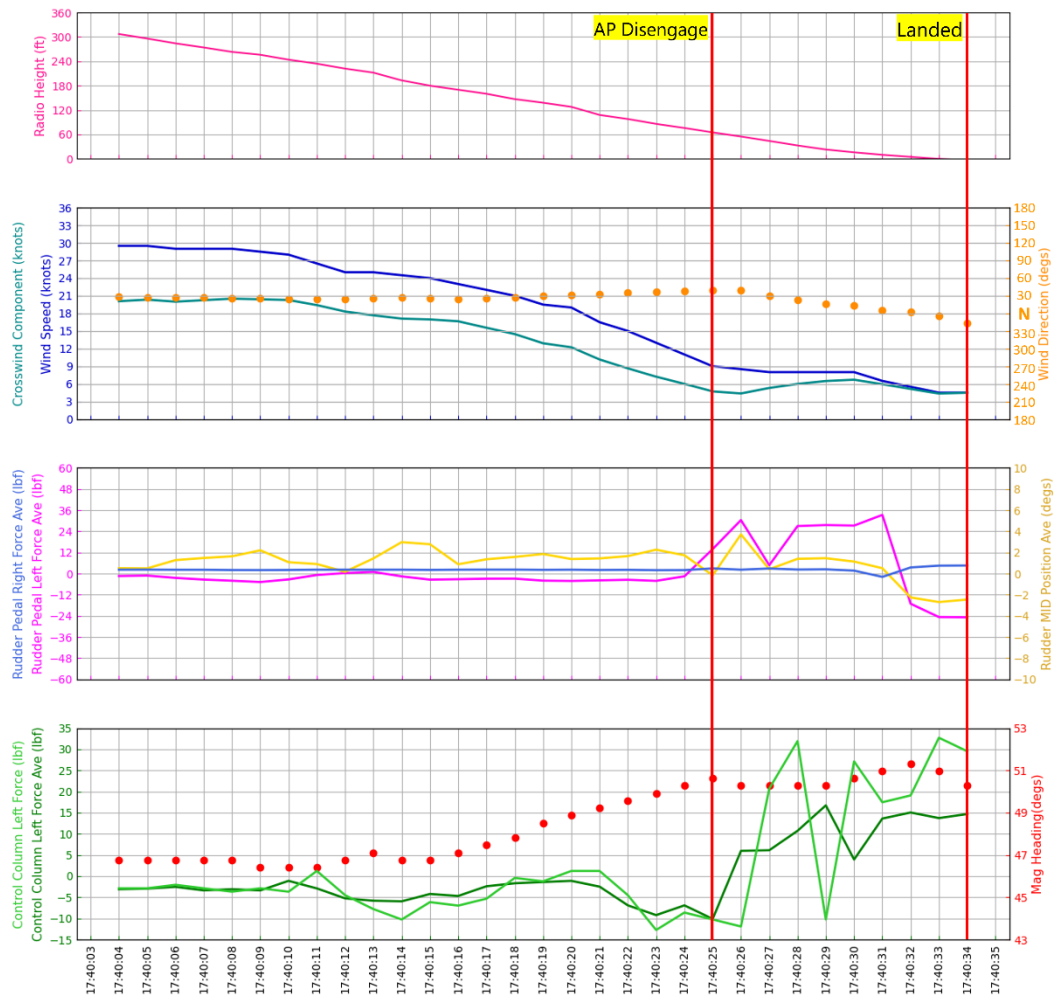


Figure 8: DFDR data

- 3.29. Two nights after the occurrence, the driver of an AIAL vehicle was conducting an inspection of runway 05R. They were focusing on the area of the damaged runway edge lights when they identified the wheel marks left by the aeroplane's right main landing gear (see Figure 9). The marks had not been visible during the day. The slight offset of each pair of tyres, supported by the DFDR information, showed that the aeroplane had been pointing back towards the runway, but the momentum had still been moving the aeroplane right towards the lights.



Figure 9: Tyre marks on runway 05R showing direction of aeroplane

(Credit: Auckland International Airport Limited)

Pilot guidance

- 3.30. The FCTM for the Boeing 777 described the landing techniques applicable to all situations, including crosswind landings and landings on slippery runways. It stated the need to 'begin with a stabilised approach on speed, in trim and on glidepath'. This was immediately followed by a note that stated:

When a manual landing is planned from an approach with the autopilot connected, the transition to manual flight should be planned early enough to allow the pilot time to establish airplane control before beginning the flare. The PF should consider disengaging the autopilot and disconnecting the autothrottle (if desired) 1–2 nm before the threshold, or approximately 300–600 feet (90–180 m) above field elevation. (Chapter 6 Landing, page 6.8)³⁶

- 3.31. In this occurrence two separate but related factors contributed to the aeroplane veering off the runway. Firstly, as described in paragraph 3.26, when the autopilot was disengaged, the flight controls would move immediately to their neutral position. The PF therefore needed to anticipate this to ensure there was no unintended deviation from the intended flightpath. In this occurrence, only 9 seconds passed between disengaging autopilot and landing. This meant there was insufficient time to reapply the left aileron, avoid the right roll and prevent the aeroplane starting to drift right.
- 3.32. Secondly, only 4 seconds passed between the autopilot being disengaged and the commencement of the flare to land. This late disengagement meant there was

³⁶ The autothrottle remains engaged until reverse thrust is selected after touchdown.

insufficient time, as described in the FCTM, to assess the changing wind conditions and 'establish airplane control before beginning the flare'.

- 3.33. In some situations, it is desirable to leave the autopilot engaged until late in the approach, for example when there is a low cloud base or a preceding aircraft is slow to clear the runway, requiring a go-around. In these scenarios the continued use of the autopilot gives pilots a greater capacity to manage the situations. However, in order to do this successfully pilots must understand how the autopilot manipulates the flight controls, especially in a crosswind, and 'back up' the control inputs just before autopilot disengagement.
- 3.34. The operator's Boeing 777 flight training manager advised that the disengagement manoeuvre in a crosswind was demonstrated in initial type training but did not form part of annual refresher training. There was, therefore, a risk of this skill being eroded over time. The operator's internal investigation into the occurrence identified a similar concern by recommending a review of the policy and guidance regarding low autopilot disengagements, referencing the Boeing FCTM guidance on the subject. Further, awareness around the importance of back-driven autopilot inputs could be included in the operator's evidence-based training programme.

Data review

- 3.35. The Commission requested a review of the operator's Boeing 777 and Boeing 787 fleets to determine if the late autopilot disengagement was an isolated case, or an example of a wider issue. This involved the operator collating data from some 4450 approaches and landings worldwide since the post COVID-19 lockdown in 2020, focusing on when the autopilot was disengaged in anticipation of a manual landing.
- 3.36. Of the 4450 manual landings, on average, the autopilot was disengaged at about 680 ft (207 m) on approach. The autopilot was disengaged below 300 ft (91 m) on some 250 occasions (about 6% of all disengagements). There can be good operational reasons for disengaging an autopilot at a low height.
- 3.37. About 60% of the 4450 manual landings took place at Auckland. Most of these were on runway 23L, where autolands were permitted. However, the number of disengagements below 300 ft was about the same for both runways: 70 for runway 05R and 76 for runway 23L. The next highest number of autopilot disengagements below 300 ft was 32 on runway 25L at Los Angeles. A discussion with the operator suggested that the higher traffic density at Los Angeles increased the probability of traffic on the runway ahead requiring go-arounds. The autopilot was left engaged until later to make a potential go-around easier to fly.
- 3.38. The operator also suggested that the higher number of autopilot disengagements in Auckland compared to those in other places reflected the fact that it was the home base³⁷ for the pilots. They were therefore familiar with the aerodrome and the runways, and **likely** to have more confidence in their ability to initiate a later autopilot disengagement for a manual landing there than they would have elsewhere.
- 3.39. There was insufficient data to indicate if this was a steady or growing trend. Nevertheless, there was sufficient data to show that it was not uncommon for pilots to disengage the autopilot at heights below the FCTM guidelines. However, this reduces the time available to pilots to ensure they have full control of aeroplanes

³⁷ Where pilots would commence and conclude their rosters.

before landing. Pilots therefore need to be proficient in correctly transitioning from automatic to manual flight. Degradation of this proficiency is a risk factor that the operator has identified (see section 5, Safety action taken).

- 3.40. Regardless of when an autopilot is disengaged, the rest of the crew need to be aware of the PF's intentions. This is where a crew briefing is vitally important. It is discussed further in the following section.

Approach and landing briefing

Safety lesson: A thorough approach briefing helps ensure a flight crew has a clear and unified understanding of the planned action and potential risks or threats when conducting that action. As a result, the crew is better able to collectively identify threats and action strategies to mitigate those threats to ensure a safe outcome.

- 3.41. The CVR recording showed that, as the aeroplane approached the start of descent into Auckland, the flight crew obtained the current weather information before being cleared for the arrival procedure for runway 05R. The PF then informed the crew that the arrival procedure and instrument approach for runway 05R had been loaded into the FMC. As the aeroplane descended, the crew occasionally discussed the weather conditions and what they might expect. The crew also confirmed that there was sufficient fuel remaining should they not be able to land at Auckland.
- 3.42. The operator's Boeing 777 SOPs and FCTM gave pilots guidance on operating the aeroplane, including the conduct of an approach briefing. The SOPs stated that the purpose of the briefing was to:
- identify threats relevant to the approach
 - identify strategies to manage those threats
 - confirm the planned operation of the aircraft.

The briefing was to follow the T-CTWO mnemonic. See Appendix 1 for the full procedure.

- 3.43. The FCTM provided further guidance on the information that should be included in an approach and landing briefing. This included specific reference to the Autopilot and Flight Management System (labelled as the AFDS in the FCTM). See Appendix 2 for the full list of briefing considerations.
- 3.44. The purpose of a crew briefing is to ensure that the crew has a common and clear understanding of how an aircraft is to be operated. On 27 January 2023, the approach and landing information given by the PF to the other two pilots consisted of naming the arrival procedure to be followed and the anticipated instrument approach and advising that these had been loaded into the FMC. There was also some general discussion on the weather and fuel states.
- 3.45. Were a pilot flying intending to disengage the autopilot significantly below the suggested height range, they should brief the crew of this so that they all share the same mental model, for example: 'I will not disengage until assured of a landing'. Even an initial indication, which can be updated, is better than leaving a crew unsure of what is intended.

- 3.46. The limited approach and landing briefing was not questioned by the other flight crew. A full recital of the briefing information detailed in the SOPs and FCTM may have been unwarranted, but the crew was still required to agree on some details. These included the minimum safe altitude, final approach speed, landing minima, flap setting, autobrake setting, amount of reverse, where they planned to exit the runway and the taxi route to the parking stand.
- 3.47. Auckland was the home base for the crew. They would therefore have been very familiar with the planned arrival procedure, the instrument approach, the aerodrome and the local environs, including threats and terrain. The review of the CVR confirmed that the crew were in agreement to continue with the approach and landing. It was therefore determined that the standard of the briefing given by the PF was **exceptionally unlikely** to have contributed to the runway excursion.
- 3.48. The investigation was unable to determine if this was an isolated example or an indication of a wider systemic issue. However, the Commission investigators spoke to several of the operator's staff during the investigation, including safety personnel and Boeing 777 training staff. All agreed that when undertaking training and check flights on aeroplanes and in simulators, pilots would more rigidly adhere to company procedures and guidelines and conduct interactive briefings using the T-CTWO mnemonic than they would in an environment without the same pressure. Those spoken to voiced concerns that since the COVID-19 lockdown pilots had had the potential to become less disciplined in the conduct of their briefings.

4 Findings

Ngā kitenga

- 4.1. The flight crew was aware of the prevailing conditions, which were inclement but still suitable for the approach and landing.
- 4.2. There was a shift in the wind direction and velocity in the final stages of the approach. This resulted in the autopilot applying control inputs to maintain the approach profile and align the aeroplane with the runway.
- 4.3. The autopilot was disengaged at 67 ft (20 m), when the operator's procedures suggested disengaging the autopilot at 300–600 ft (90–180 m). The late disengagement was **likely** because of the inclement weather on the approach.
- 4.4. When the autopilot was disengaged, the autopilot control inputs ceased, and the flight and pilot controls returned to a neutral position. This resulted in the aircraft rolling to the right and drifting right of the centreline. It is **very likely** that the pilot flying did not hold the same control inputs set by the autopilot when they disengaged the autopilot.
- 4.5. The aeroplane veered off the runway as soon as the main landing gear contacted the runway, striking six runway lights and damaging the right main landing gear.
- 4.6. It was **exceptionally unlikely** that the rain caused contamination on the runway leading to a loss in directional control and resulting in the runway excursion.
- 4.7. The frangible runway edge lighting worked as designed.
- 4.8. The crew proactively reported to the tower a possible runway excursion in response to a low-tyre-pressure indication during the landing roll. In response, the tower closed the runway and had it inspected for foreign object debris.
- 4.9. The crew approach and landing briefing did not meet the intent of the operator's guidelines. However, it was **exceptionally unlikely** that this contributed to the occurrence.

5 Safety issues and remedial action

Ngā take haumarū me ngā mahi whakatika

General

- 5.1. Safety issues are an output from the Commission's analysis. They may not always relate to factors directly contributing to the accident or incident. They typically describe a system problem that has the potential to adversely affect future transport safety.
- 5.2. Safety issues may be addressed by safety actions taken by a participant. Otherwise the Commission may issue a recommendation to address the issue.

Safety issue

Autopilot disengagement

Safety issue: The procedure and techniques to be used when disengaging the autopilot in a crosswind are taught during the initial conversion course only. Without regular practice, this skill can erode with time, increasing the risk of an incorrect handling technique leading to a runway excursion.

Safety action taken:

- 5.3. The operator's operational safety report on the occurrence recommended that the operator's standards and training section and the flight operations section consider using the lessons learnt from the occurrence within their evidence-based training environment. The report also highlighted that this may include the following:
 - strategies to mitigate unexpected flight control inputs at low level when disconnecting the autopilot in adverse weather e.g., reinforcing autopilot disconnect at an earlier stage to allow for timely control input/corrections. This should include awareness around the importance of back-driven autopilot inputs prior to autopilot disconnection.
 - Flight operations to consider policy/guidance regarding late disconnection of the autopilot on approach. This may expand on formalising the current guidance in the Boeing FCTM where pilots should disconnect the autopilot "early enough to allow the pilot time to establish airplane control before beginning the flare". It should be reinforced to crew that the intended autopilot disconnect point be included in the approach briefing to ensure a shared mental model is established between crew members of how the automation is expected to be managed.
- 5.4. On 11 August 2023, the operator issued an internal flight safety bulletin to pilots providing a summary of the occurrence and preliminary findings.
- 5.5. The operator advised that their Flight Operations Quality Assurance (FOQA) event criteria had been amended to capture lateral deviations from the final approach path. This data will assist in identifying any safety-related trends that require addressing.
- 5.6. The operator advised that the Standards and Training department had developed and implemented a scenario-based training module for pilots involving disengaging of the autopilot on final approach in crosswind conditions. The purpose of this training

was to reinforce the technique for the smooth transition from autopilot to manual control by mirroring/holding controls inputs at the point of disconnection.

- 5.7. The operator advised that their quarterly safety publication for December 2023 featured an editorial by the Head of Flight Operations titled 'Recover to Safety – The First Course of Action'. This article reinforced expectations for the prevention and recovery from an unstable approach or undesired aircraft state.
- 5.8. The Commission welcomes the safety action taken by the operator and as a result no safety recommendation was made.

Other action taken

- 5.9. The operator advised that in August 2024 it had issued a procedural instruction to Boeing 777 flight crew regarding briefing and standards calls for go-arounds, including thrust setting. This instruction was based on a Boeing Operations Manual Bulletin. Although these instructions did not specifically refer to autopilot disconnect height, they do raise awareness of briefing key items and support go-around readiness.
- 5.10. The operator advised that it had not previously identified any issues with crew approach briefings through routine monitoring, training and examination. Noting that, unlike the Commission, the operator did not have the ability to review CVR recordings, the information contained within the Commission's draft report was new information which they will consider as part of ongoing safety improvements. The operator was reviewing its philosophy with respect to approach briefings, moving from a required list of items to be covered to a more flexible format that allows crews to focus on threats, differences and key items. This would begin with the Airbus fleet and extend to Boeing 777/Boeing 787 operations.

6 Recommendations Ngā tūtohutanga

General

- 6.1. The Commission issues recommendations to address safety issues found in its investigations. Recommendations may be addressed to organisations or people, and can relate to safety issues found within an organisation or within the wider transport system that have the potential to contribute to future transport accidents and incidents.
- 6.2. In the interests of transport safety, it is important that recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.
- 6.3. Following the reporting of this occurrence the operator completed their own internal investigation. As a result, it has undertaken a range of actions to address the safety issue. Following the distribution of the draft report by the Commission, the operator has undertaken additional action regarding the safety issue and lesson.
- 6.4. The Commission notes the actions taken and has not issued any further safety recommendations.

7 Key lesson

Ngā akoranga matua

- 7.1. Operator and aircraft manuals and procedures, supported by an effective and recurrent training programme, help ensure an aircraft is flown as safely as possible in both normal and adverse circumstances. Being familiar with, and adhering to, these documents is therefore essential.
- 7.2. A thorough briefing is a core element of crew resource management (CRM) and is essential in helping ensure a crew has a clear and unified understanding of what is intended and is therefore as prepared as possible for managing the risks and ensuring a safe outcome.

8 Data summary

Whakarāpopoto raraunga

Aircraft particulars

Aircraft registration:	ZK-OKN
Type and serial number:	Boeing 777-319ER, 38406
Number and type of engines:	2 General Electric GE90-115B turbofans
Year of manufacture:	2011
Operator:	Air New Zealand
Type of flight:	regular passenger transport
Persons on board:	287

Crew particulars

Captain

Licence:	airline transport pilot licence (aeroplane)
Age:	63
Total flying experience:	24,000 hours (5183 hours on type)

First officer

Licence:	airline transport pilot licence (aeroplane)
Age:	59
Total flying experience:	19,415 hours (5248 hours on type)

Second officer

Licence:	airline transport pilot licence (aeroplane)
Age:	39
Total flying experience:	7642 hours (125 hours on type)

Date and time 27 January 2023, 1740

Location Auckland Aerodrome
latitude: 37° 00.5' south
longitude: 174° 47.5' east

Injuries nil

Damage six runway edge lights, right main landing-gear tyres, wiring harness and brackets

9 Conduct of the inquiry

Te whakahaere i te pakirehua

- 9.1. On 27 January 2024, the Civil Aviation Authority notified the Commission of the occurrence. The Commission subsequently opened an inquiry under section 13(1) of the Transport Accident Investigation Commission Act 1990 and appointed an Investigator-in-Charge.
- 9.2. Following the occurrence the operator quarantined the aeroplane in a hangar to await the arrival of the Commission's investigation team. A protection order was issued to ensure the aeroplane's CVR and DFDR were secured. The two recorders were later removed from the aeroplane under the supervision of a Commission investigator and taken to the ATSB's laboratory in Canberra for downloading.
- 9.3. The Commission's investigation team examined the aeroplane, interviewed the flight crew, met with key staff and collected relevant operator, aeroplane and crew information. The investigation team also met with aerodrome operator staff and inspected the runway. They collected relevant CCTV recordings, occurrence information and aerodrome procedures. Air traffic control recordings of the flight and weather data were also obtained.
- 9.4. On 12 April 2023 the investigation team met with several of the operator's simulator instructors and flew a range of approaches and landings utilising the operator's Boeing 777 simulator. On 16 February 2024 the investigation team met with the operator's Boeing 777/Boeing 787 training and safety staff.
- 9.5. On 24 July 2024 the Commission approved a draft report for circulation to seven interested parties for their comment. Six interested parties responded, two of which made submissions.
- 9.6. On 27 November 2024 the Commission approved a revised draft report and sought further comment from the two interested parties that had been affected by changes in the report. The Commission considered these submissions in detail. Any changes as a result of the submissions from all interested parties have been included in the final report.
- 9.7. On 30 April 2025 the Commission approved this final report for publication.

Abbreviations

Whakapotonga

AGL	above ground level
AIAL	Auckland International Airport Limited
AMSL	above mean sea level
ATIS	automatic terminal information service
ATSB	Australian Transport Safety Bureau
CCTV	closed-circuit television
CFIT	controlled flight into terrain
CRM	crew resource management
CVR	cockpit voice recorder
DFDR	digital flight data recorder
DME	distance measuring equipment
FCOM	flight crew operations manual
FCTM	flight crew training manual
FMC	flight management computer
FOD	foreign object debris or damage
h	hour
hPa	hectopascal
ILS	instrument landing system
km/h	kilometres per hour
kt	knot
m	metre
METAR	routine meteorological report
min	minute
mm	millimetres
NOTAM	notices to air missions
PF	pilot flying
PM	pilot monitoring
SOPs	standard operating procedures
STAR	standard arrival route

Glossary

Kuputaka

autoland	a landing using the autopilot, with the pilot in the left seat taking over directional control during the landing roll (when the aircraft touches down, is brought down to taxi speed and eventually comes to a complete stop)
frangible	easily broken
overrun	aircraft departs the end of a runway
runway excursion	aircraft departs the runway in use when landing or taking off and is either a veer-off or an overrun
veer-off	aircraft departs the side of a runway

Citations

Ngā tohutoru

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Appendix 1 Air New Zealand: Standard Operating Procedures

Normal Procedures

Descent

Approach Briefing (T-CTWO)

The purpose of the briefing is to:

- identify threats relevant to the approach
- identify strategies to manage those threats
- confirm the planned operation of the aircraft.

The approach briefing should be completed prior to TOD but not later than 20,000 ft.

A preparation phase is required prior to the briefing being delivered. The preparation for arrival requires that:

- FCOM procedures are complete
- FMC has been loaded and checked
- navigation aids are set
- NOTAMS checked
- Aircraft type configuration differences, OMB, DDG/CDL are reviewed
- each pilot has read the destination airport's Route Guide pages
- the touchdown zone limits should be discussed
- any questions about the preparation phase have been resolved.

The briefing phase follows the mnemonic T-CTWO and commences after establishing that the preparation phase is completed and the other crew members are ready for the briefing.

Threats Identify the relevant threats from the Route Guide airport pages and other threats specific to the flight. Establish strategies to manage them.

Chart

- State the cleared STAR, TRANS, APP and RWY.
- Check the correct charts are being used.
- Display the FMC RTE pages showing the cleared STAR, TRANS, APP and RWY.
- State constraints that have been modified or not coded in the FMC.
- Identify the transition level.
- For an instrument approach in IMC or at night, state:
 - the profile intercept point
 - second profile check
 - MDA/DA/DH
 - visibility minimums.

Terrain State the method(s) that will be used to ensure terrain clearance, e.g. radar terrain, sector MSAs or “**Visual terrain clearance**”.

Weather Identify significant weather, otherwise state, “**Nil significant weather**”.

Operational

- Identify operational considerations.
- State the stable gate altitude.
- Compare fuel state and MIN RES. Quantify surplus fuel.
- Conclude the arrival briefing by confirming crew understand the briefing and that there are no further questions

Appendix 2 Boeing Flight Crew Training Manual

Approach Briefing

Before the start of an instrument approach, the PF should brief the PM of his intentions in conducting the approach. Both pilots should review the approach procedure. All pertinent approach information, including minimums and missed approach procedures, should be reviewed and alternate courses of action considered.

As a guide, the approach briefing should include at least the following:

- weather and NOTAMS at destination and alternate, as applicable
- type of approach and the validity of the charts to be used
- navigation and communication frequencies to be used
- minimum safe sector altitudes for that airport
- approach procedure including courses and heading
- vertical profile including all minimum altitudes, crossing altitudes and approach minimums
- speed restrictions
- determination of the Missed Approach Point (MAP) and the missed approach procedure
- landing distance required for current conditions compared to landing distance available
- other related crew actions such as tuning of radios, setting of course information, or other special requirements
- taxi routing to parking
- any appropriate information related to a non-normal procedure, including non-normal configuration landing distance required versus landing distance available
- management of AFDS.

Kōwhaiwhai - Māori scroll designs

TAIC commissioned its four kōwhaiwhai, Māori scroll designs, from artist Sandy Rodgers (Ngāti Raukawa, Tūwharetoa, MacDougal). Sandy began from thinking of the Commission as a vehicle or vessel for seeking knowledge to understand transport accident tragedies and how to avoid them. A 'waka whai mārama' (i te ara haumarū) is 'a vessel/vehicle in pursuit of understanding'. Waka is a metaphor for the Commission. Mārama (from 'te ao mārama' – the world of light) is for the separation of Rangitāne (Sky Father) and Papatūānuku (Earth Mother) by their son Tāne Māhuta (god of man, forests and everything dwelling within), which brought light and thus awareness to the world. 'Te ara' is 'the path' and 'haumarū' is 'safe' or 'risk free'.

Corporate: Te Ara Haumarū - the safe and risk free path



The eye motif looks to the future, watching the path for obstructions. The encased double koru is the mother and child, symbolising protection, safety and guidance. The triple koru represents the three kete of knowledge that Tāne Māhuta collected from the highest of the heavens to pass their wisdom to humanity. The continual wave is the perpetual line of influence. The succession of humps represents the individual inquiries.

Sandy acknowledges Tāne Māhuta in the creation of this Kōwhaiwhai.

Aviation: Ngā hau e whā - the four winds



To Sandy, 'Ngā hau e whā' (the four winds), commonly used in Te Reo Māori to refer to people coming together from across Aotearoa, was also redolent of the aviation environment. The design represents the sky, cloud, and wind. There is a manu (bird) form representing the aircraft that move through Aotearoa's 'long white cloud'. The letter 'A' is present, standing for a 'Aviation'.

Sandy acknowledges Ranginui (Sky father) and Tāwhirimātea (God of wind) in the creation of this Kōwhaiwhai.

Maritime: Ara wai - waterways



The sections of waves flowing across the design represent the many different 'ara wai' (waterways) that ships sail across. The 'V' shape is a ship's prow and its wake. The letter 'M' is present, standing for 'Maritime'.

Sandy acknowledges Tangaroa (God of the sea) in the creation of this Kōwhaiwhai.

Rail: rerewhenua - flowing across the land



The design represents the fluid movement of trains across Aotearoa. 'Rere' is to flow or fly. 'Whenua' is the land. The koru forms represent the earth, land and flora that trains pass over and through. The letter 'R' is present, standing for 'Rail'.

Sandy acknowledges Papatūānuku (Earth Mother) and Tāne Mahuta (God of man and forests and everything that dwells within) in the creation of this Kōwhaiwhai.



Transport Accident Investigation Commission

Recent Aviation Occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

AO-2023-011	ZK-JED BE76 / ZK-WFS C172, near mid-air collision, Ardmore Aerodrome, 3 October 2023
AO-2023-010	Kawasaki BK117 B-2, ZK-HHJ, collision with terrain, Mount Pirongia, 19 September 2023
AO-2022-005	Boeing 737-484SF, ZK-TLL, Incorrect fuel configuration, Sydney to Auckland, 7 June 2022
AO-2023-001	Airbus Helicopters AS350B2 (ZK-IDB) and EC130B4 (ZK-IUP), reported close air proximity, Queenstown Aerodrome, 27 December 2022
AO-2018-009	MD Helicopters 500D, ZK-HOJ, In-flight breakup, near Wānaka Aerodrome, 18 October 2018
AO-2022-002	Robinson R22, ZK-HEQ, loss of control inflight, Karamea, West Coast, 2 January 2022
AO-2021-003	Airbus Helicopters AS350 B3e, ZK-ITD, loss of control in flight, Lammerlaw Range, 40 km northwest of Dunedin Aerodrome, 16 September 2021
AO-2020-002	Glider, Schleicher ASK21, ZK-GTG, Impact with Terrain, Mount Tauhara, Taupō, 31 May 2020
AO-2022-001	Ultramagic Balloons, N-250, ZK-MET, pilot ejection from basket on landing, Lyndhurst, near Methven, 1 January 2022
AO-2021-001	Kavanagh Balloons E-260, ZK-FBK, hard landing and ejection of occupants, Wakatipu Basin, near Arrowtown, 9 July 2021
AO-2019-007	Air traffic services outage, 30 September 2019
AO-2019-005	BK-117-C1 ZK-IMK controlled flight into terrain (water), Auckland Islands, 22 April 2019

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